FEASIBILITY STUDY FOR CONSTRUCTION AND OPERATION OF AN ENDANGERED FISH REARING FACILITY ON THE HUALAPAI RESERVATION

Final Report as per Cooperative

Agreement No. 3-FC-30-00100

Between the Bureau of Reclamation and the

Hualapai Tribe

Prepared for

USDI BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470
Phone # 702-293-8703

Prepared by
Hualapai Department of Natural Resources
P.O. Box 300
Peach Springs, Arizona 86434
Phone # 602-769-2255
Fax # 602-769-2309

March 31, 1995

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

PROJECT DESCRIPTION

The Hualapai Tribe is proposing to construct an Endangered Fish-Rearing Facility on the Hualapai Reservation in northwestern Arizona. The facility will be built on approximately 80 acres and will consist of eight concrete raceways, eight brood ponds, four nurse ponds, twelve rearing ponds, one holding pond, a recirculation system, employee housing, maintenance and laboratory buildings.

The proposed facilities would address the immediate need for a rearing facility for razorback suckers, *Xyrauchen texanus* and other endangered and/or native species for reintroduction into tribal and non-tribal waters. The Hualapai Reservation is an ideal location for the facility because of it's proximity to the Grand Canyon and due to the available resources the Reservation can provide, namely land and water.

BACKGROUND

The construction of Glen Canyon Dam and it's subsequent operation have contributed to the decline of the native fishes of the Colorado River in the Grand Canyon (Minckley and Deacon 1991). Only four of the eight species that occurred in predam times remain as viable populations. A fifth, the razorback sucker, is still abundant in Lake Mohave, but it's population is declining. In 1990 the population estimates in Lake Mohave totaled 60,000 and today that estimate has declined to nearly 25,000 (Burke 1994). The altered water temperature regime, daily discharge fluctuations and the presence of introduced fishes are believed to be responsible for the decline of the native fish fauna. At this time, the Final Glen Canyon Dam Environmental Impact Statement (FGCDEIS) is proposing to reduce daily discharge fluctuations and to study how the modification of dam operations might allow for warming of Colorado River water to enhance native fish populations.

The status of threatened and native fishes of the Colorado River through the Grand Canyon have been the subject of increasing concern during the present FGCDEIS and subsequent Final Biological Opinion and Reasonable and Prudent Alternative developed by the U.S. Fish and Wildlife Service (Service). Both documents contain elements that address the need to establish a second population of the endangered humpback chub, *Gila cypha* and to design and implement plans to recover the endangered razorback sucker, *Xyrauchen texanus* in the Grand Canyon.

Presently, only one facility in the Southwest, Dexter National Fish Hatchery and Training Center (DNFHTC), is fully dedicated to rearing endangered fishes. Johnson and Jensen (1991), however, expressed a need for additional facilities to rear and maintain native fish populations. The proposed Hualapai facility would provide a state of the art fish rearing system to enhance the potential for future recovery of endangered southwestern fishes. It is also wise to have more than one facility raising these fishes to maintain genetic diversity in the species and to safeguard against catastrophic losses due to accidents.

OBJECTIVES:

1. To rear razorback suckers and other threatened and/or native fishes for reintroduction into mainstream Colorado River and/or it's tributaries on Hualapai Tribal Lands and other sites within the historic range of the species.

2. Provide economic development and education for the Hualapai Tribe by providing employment and training in fish rearing and aquatic biology for students at the facility.

PRODUCTS:

1. Razorback suckers and/or other native fishes greater than 300mm available for stocking into waters of their historic range.

2. Employment, education and training for Hualapai and non-Hualapai individuals.

I. SITE LOCATION AND DESCRIPTION

Initially, we selected seven sites for consideration as localities for the proposed Endangered Fish Rearing Facility (Figure 1). Because of a lack of available water, power, and/or access, five of these sites were eliminated from consideration. The remaining two sites, the Santa Fe Site at Fraziers Well and the Peach Springs Canyon site, were subjected to further examination where issues of flood potential, sewage runoff, and cultural significance were addressed.

Because of the potential for flooding and sewage runoff, the Peach Springs site was eliminated from consideration by the work group who met to discuss the feasibility of the proposed project (see Section XI. NEPA Coordination below). The Santa Fe site was therefore considered to be the preferred site as it has an ample water supply, land availability, existing utilities to the site, there is no potential for flooding, the terrain is of adequate slope, suitable access, there is no likely impact to threatened or endangered species, and there is no likely impact to cultural resources (Figure 2).

The Santa Fe site is located 29 miles northeast of Peach Springs on Route 18. Specific attributes of the area are as follows:

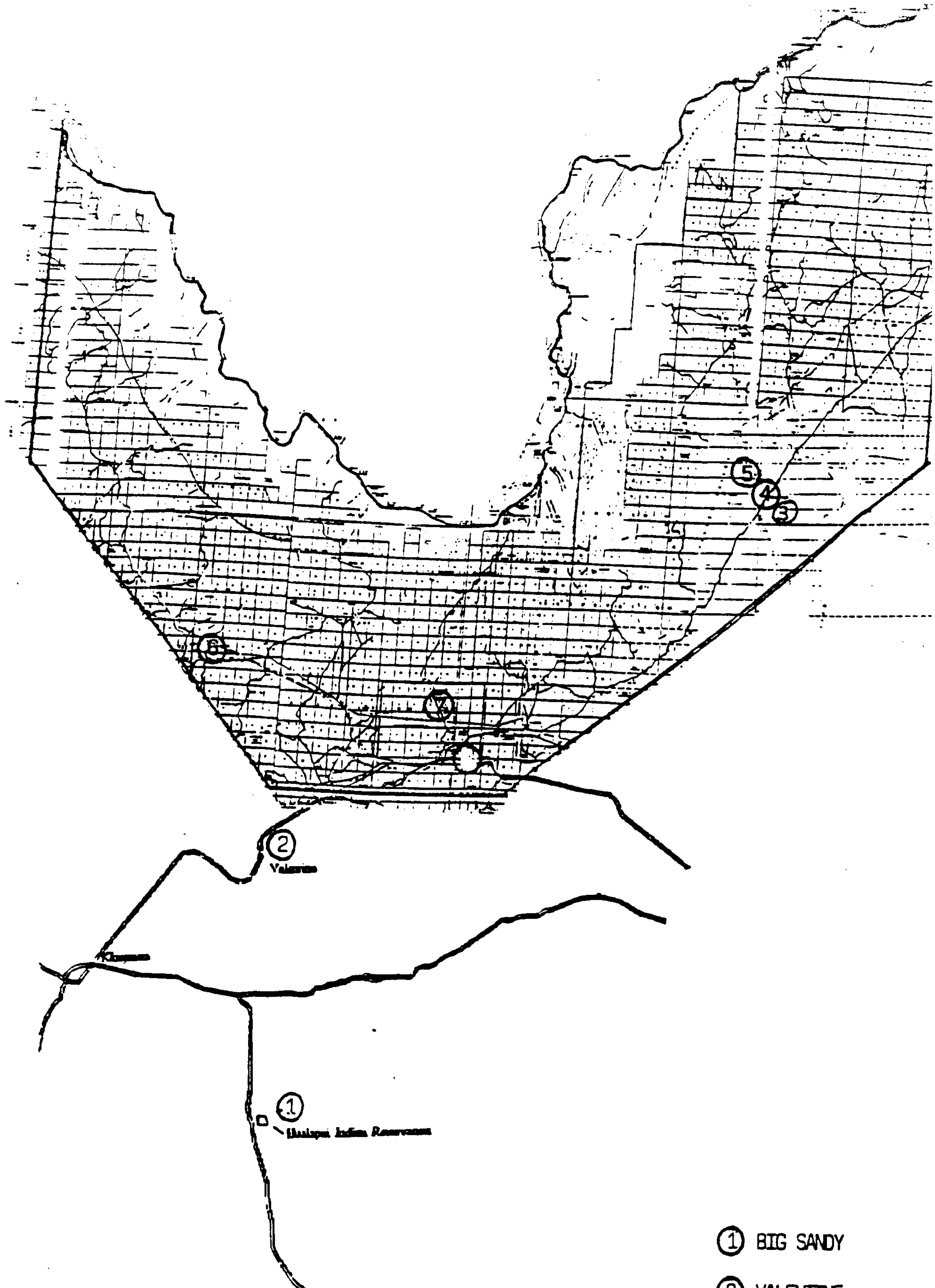
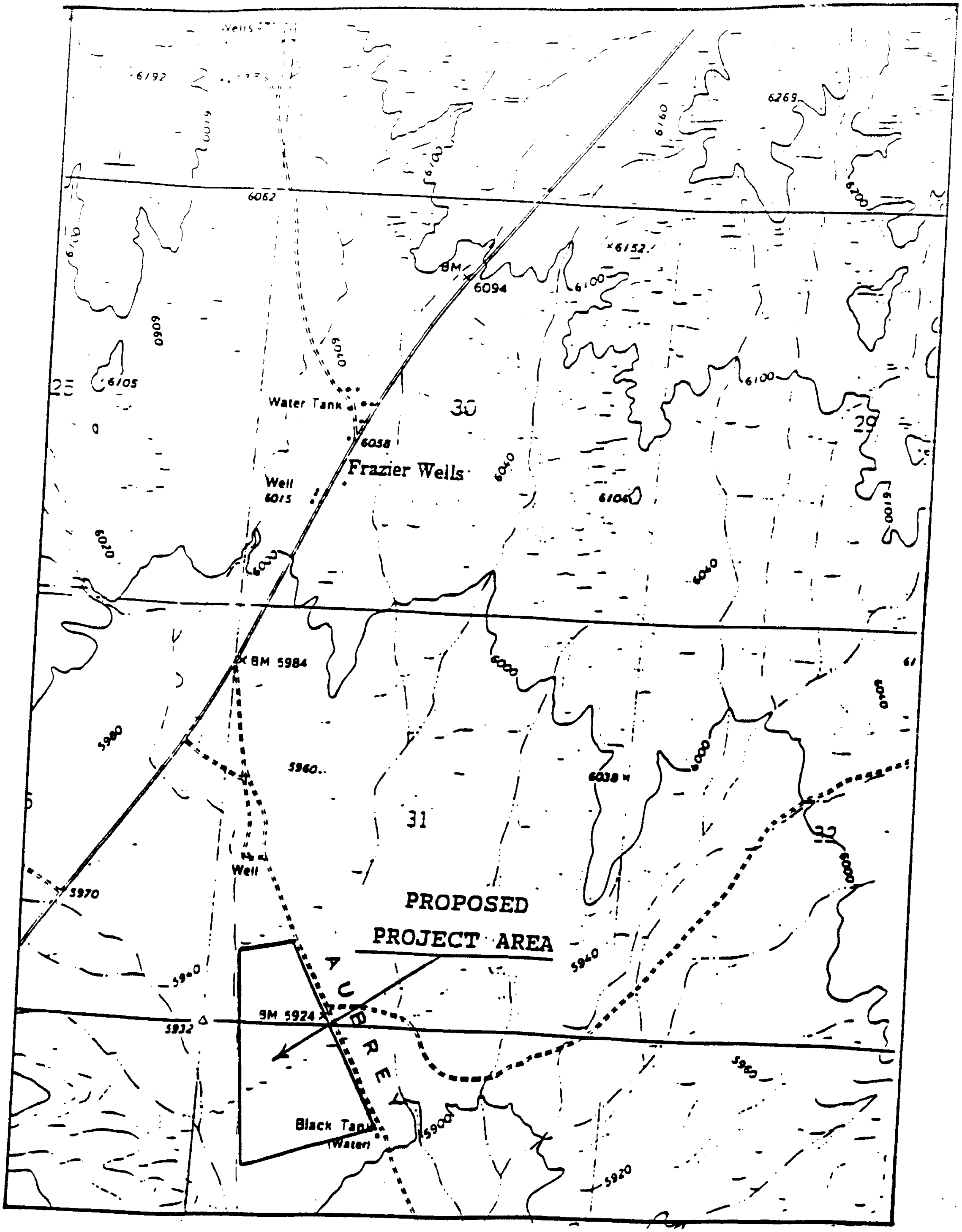


Figure 1 Diagram of the sites evaluated as potential locations for the Endangered Fish Rearing Facility.

Figure 2. Proposed Project Area for the Endangered Fish Rearing Facility



T 28N-R 7W, SW¼, SW¼, SEC.31

NW¼, NW¼, SEC. 6

Frazier Well Quad.

Gila and Salt River Meridian 7.5 Series

ARIZONA

Setting:

Landform - draws and fan terraces
Flooding - rare, brief runoff from adjacent slopes
Slope range - 1 to 3 percent
Elevation - 5,800 to 6,000 feet (Site area - 5,924 feet)
Mean annual precipitation - 13 to 15 inches
Mean annual soil temperature - 52 to 56 degrees F
Frost-free **period** - 130 to 160 days

% Soil Composition:
65% Frazwell and similar soils
25% Concho and similar soils
10% Contrasting inclusions

Typical Soil Profiles:

Frazwell Soil 65%
0-1 inch brown loam
2-11 inch dark brown loam
11-41 inch dark brown and brown sandy clay loam
41-72 inch reddish yellow stratified coarse sand and loamy sand
72-80 inch brown sandy clay loam

Concho Soil 25%
0-1 inch brown fine sandy loam
1-9 inch dark brown sandy clay loam
9-34 inch brown clay
34-52 inch stratified brown sandy clay loam and clay loam
52-59 inch brown sandy loam
59-65 inch brown cobbly fine sandy loam

II. PROFESSIONAL ENGINEERING COSTS AND REQUIREMENTS

It is estimated that a complete set of plans in the format requested by BOR will require approximately $75,000.00 as estimated by Keeton Fisheries Consultants, Inc.. See Section IV below.

III. WATER QUALITY AND QUANTITY

A "drawdown" test was performed on the Santa Fe Well by Universal Drilling of Wickenberg, Arizona on June 9-10, 1993, report can be found in Appendix A. The findings of the test are as follows:

1. Static water level 51 feet
2. Total depth of well 130 feet
3. Set test pump 112 feet
4. Estimate gallons per minute 71

Seventy-one (71) gallons per minute is an adequate supply for fish rearing facility, but it will be the limiting factor regarding the size of the facility.

The results of a water quality analysis of the water flowing from the Santa Fe Well are given in Table I. The samples were collected on June 9, 1993 and analyzed on July 20, 1993 by Bureau of Reclamation, Lower Colorado River (BOR-LCR) personnel, Appendix B. In general, the water flowing from the well is of high quality and acceptable for supplying a fish rearing facility.

Table I. Results of water quality analysis performed on water from the Santa Fe Well at Frazier Wells, Samples collected 6-9-93.

No.	pH	EC (mmho)	TDS (mg/l)	/--Cations(mg/l)--/ %NA	NA	K	CA	MG	/-----Anions-------/ CO3	HCO3	CL	SO4	NO3 (mg/l)
1													24.7
2													25.4
3													25.3
4	7.4	401	237	9.9	10	0.0	76	7	0	219	13	19	
5	7.5	405	247	9.6	10	1	75	6	0	213	8	19	
6	7.6	413	258	10.3	10	1	68	6	0	217	10	18	

IV. PRELIMINARY SITE PLAN AND ENGINEERING PLAN

***The following has been prepared with the help of Keeton Fisheries Consultants, Inc. of Fort Collins, Colorado.**

SYSTEM OVERVIEW

This section outlines the general overview and preliminary cost analysis for an endangered fish rearing facility. The initial Aquaculture facility will concentrate on the rearing of razorback suckers, *Xyrauchen texanus* for reintroduction into mainstream Colorado River and/or it's tributaries and other sites within the historic range of the species.

Due to limited water supply of 71 gpm (gallons per minute), proven recirculation design technology will be used to provide adequate water flows on a sustained basis to raceways, nurse ponds and grow-out ponds.

A water treatment system for nitrification is provided in the design for continuous removal of organic suspended solids and nitrates. Large treatment ponds are extremely effective in maintaining low levels of NH_3-N (ammonia-nitrogen) recirculated to the fish. Unionized ammonia levels of 0.0125 should be maintained by the designed treatment system.

Water flow rates for modern aquaculture facilities are not calculated based solely upon feeding rates and inflow D.O.levels. The design protocol should be based upon continuous aeration for raceways, nurse ponds and grow-out ponds. Aeration systems designs are designed to meet fish respiration requirements, algae respiration and B.O.D.(biological oxygen demand) requirements. Optimum growing conditions are maintained for fish on a constant basis, utilizing reconditioned recirculating water and aeration.

Design parameters on the return water system will maintain incoming recirculation water at, near, or above D.O.(dissolved oxygen) saturation for a elevation of 5924 feet dependent upon the environmental conditions. Inline multi-stage packed column oxygen concentrators in which all recirculation water must pass, maintains a saturated profile for oxygen at temperature, flow and elevation. Oxygen can be fed to the concentrator to maintain the desired level of oxygen needed in the return water. Inline oxygen concentrators ensure saturated water is delivered at all times to the fish rearing basins.

Aeration system design provides emergency oxygenation and will guard against fish mortality in the event of loss of recirculation flow. Aeration will maintain D.O. levels near 7 milligrams per liter based upon loading density requirements of each raceway, brood pond, nurse pond or grow-out pond. Each individual unit is fitted with an active aeration system fed by a common air manifold.

BACKUP SYSTEM

Redundant backup pumps and air blowers are incorporated into the design. In the event of pump or blower failure, standby units can be turned on. One large diesel powered generator will backup critical pumping and aeration components in the event of power failure.

CENTRAL AERATION SYSTEM

The central aeration system is designed to feed the grow-out, raceway and nurse pond system. A sound proofed blower room will house the main blowers for aeration. Regenerative blowers will draw filtered air from outside the building and will discharge into a cooling manifold. The cooling manifold is fitted with a pressure relief valve, pressure gauge and auto drain valve. The discharge of the manifold will feed the central distribution piping. Tapped into the distribution pipe is an ozone feed line to the main manifold. Flow meters control the mixture of ozone and Activated oxygen to the central aeration system and for O_3 (ozone) injection into the water pumpback system. All aeration equipment will be located in two blower buildings and ozone room area. This arrangement provides additional floor space and a central location for controlling all aeration. Tuff sheds are specified at each aeration and pumping site to house aeration/ozone equipment. Ozone is used to decrease B.O.D. and to sterilize return water to all basins, thereby decreasing the possibility of disease introduction.

MONITORING SYSTEMS

A centralized automated alarm system monitors all critical parameters within the recirculating system. One alarm will be located at each pump station and aeration building to monitor air and water pumping systems.

Water and air flow will be monitored by a telephone-connected microprocessor (Oscar Monitor Model #OSC-1 [Keeton Industries]). Electronic monitoring will track and display a number of parameters outlined under monitoring requirements. The monitoring unit will dial the phone number designated by the aquaculture operator to contact personnel responsible for the system at the time. Water flow, air flow, electricity, pumps, temperatures and a number of parameters can be monitored by remote probe and mercoid pressure switches.

The OSC-1 contains an uninterrupted power supply, a history report of alarms, a built-in phone directory, clock and calendar, call-back capability, programmable passwords, and programmable control/alert zones.

The Oscar Monitor (OSC-1) automatically dials any number of personnel to alert them as to a malfunction within the recirculating system. The auto dial feature continues to dial pre-programmed numbers until someone is reached.

WATER CIRCULATION SYSTEM

The rearing facility recirculation system is separated into two distinct systems. The raceways, brood ponds and nurse ponds consist of a common recirculating and waste treatment system. The same is true for the rearing pond recirculation unit.

The upper raceway aquaculture facility is fed by its own water supply. Common drain manifolds collect effluent water, where it then flows through the plate filter and finally through three one acre treatment ponds for nitrification. The long residence time in treatment ponds 1 through 3 promotes nearly complete nitrification as water passes through the three stage lagoon system. Clean water from treatment pond #3 gravity flows to a sump where it is ozonated and pumped to an inline oxygen concentrator column for distribution to raceways and ponds. Water continues through the pressure line delivery system to all raceways and ponds.

The entire water flow is gravity flow from this point through the system until it is picked up again by the recirculating pump.

The lower grow-out aquaculture system is the same except one 2.5

acre treatment pond is utilized for water reconditioning. A properly designed water circulating system assures that a constant supply of clean water is delivered to growing basins at the proper flow rate. The pumping station delivers clean (supply) water to the system. As indicated in the design specifications, a design flow rate of 2,000 and 2,120 gpm will provide the necessary waste removal and meet turnover requirements for each recirculation system. The supply portion of the circulation loop consists of several pumps piped in parallel which draw water from the sump and deliver clean water to the fish in raceways and ponds. By design, one pump serves as a backup during maintenance or failure of one pump.

Delivery of cleaned water to each fish basin represents the end of the supply section of the circulation loop. Each raceway or pond is fitted with an overflow stand pipe which is set to maintain the water level at the desired height. As clean supply water is continually pumped into each raceway or pond the discharge water passes through a coarse filter screen at the far end of the raceway or pond. Water exits through a reverse standpipe via the overflow standpipe into the return drain lines. Reverse standpipes bring solids and the poorest water quality from the bottom of the pond instead of pulling surface water.

SOLID WASTE REMOVAL AND TREATMENT SYSTEM

The drain lines bring the contaminated water from all ponds into an inline plate filter where up to 80-90% of the total suspended solids are removed from the flow. Solids and backwash liquid are dispensed to the sludge drain and transported by gravity to a waste storage pond. Incline plates are very effective in removal of solids and require little maintenance. The bulk of the solid waste (80%) is removed from the system by the incline plate filtering system. The remainder is broken down in the treatment ponds system as described for each recirculating system.

Incline plate filtering units are designed to accommodate varying hydraulic loading rates up to the design maximum loading density and flow rate. An effective incline plate design can remove on an average 80% TSS larger than 70 microns and 55% of TSS larger than 1.5 microns. Concentrated waste can be used as fertilizer or pumped to a waste lagoon storage unit. Replacement water must be added on a constant basis as makeup water to replace water loss to evaporation, flushing, other uses and plate filter backwash.

Pumps and sump systems must be covered for winter-time operations to prevent any freezing of the pipe system. All lines must be buried below frost line for year round operation.

****The following calculations are for example only and do not reflect actual proposed operations:**

OXYGEN ALLOCATION CALCULATIONS AND WATER FLOW CALCULATIONS FOR FINGERLING GROW-OUT SECTION

I. Raceways

Each of the eight concrete raceways are to be stocked with 3,750 2-3 inch razorback suckers with an average weight of 6.5 grams-8.9 grams initial weight

The anticipated holding and grow-out time in the raceways is expected to be three months.
Initial Loading Density 53.63 pounds = 24.37 kg/raceway
Final projected loading density 73.51 pounds
= 33.41 kg/raceway
D.O. design for incoming water = 7.0 mg/l minimum
(Seven milligrams per liter represents average incoming dissolved oxygen)

STANDARD OXYGEN CONSUMPTION for warm water fish species at full feed is given as follows:

Where W = fish weight in grams
$Y = 0.001W^{0.82}$
$Y = 0.001(8.9)^{0.82}$
$Y = 0.006$ gm O_2/fish/hour at full feed
$Y = 0.006 \times 3{,}750$ fish = 22.50 gm/O_2/hr.
O_2 Fish Y = 540 grams O_2/raceway/day, where t=total
Y = 540 x 1.5 correction factor, where 1.5=B.O.D. correction factor for open pond systems
Total oxygen use = 810 gms O_2/raceway/day

WATER FLOW FOR FISH O_2 DEMAND

The following water flow rates have been calculated from the amount of water flow needed to support the maximum densities given for the raceways.

Flow <u>60 gpm</u> x 3.7851 = 227.101 x 60 x 7mg/l/1000
inflow O_2 = 95 grams O_2/hour
60 gpm more than provides ample oxygen for the 3 month grow-out period (2,280 grams O_2/day)
Aeration backup is given by the following equations:

$$\text{Air/raceway} - \frac{14.26}{1440(0.075)(0.232)(0.125)} = \frac{14.26}{3.13}$$

CFM (cubic feet per minute) = 12.5 cfm at 12% Transfer Rate Efficiency Per Raceway

Where:
14.26 = pounds oxygen required
1440 = minutes per day
0.075 = density of air in pounds per cubic foot
0.232 = Laboratory transfer rate

efficiency
0.125 = average field transfer rate efficiency for air stones at three feet submergence

Airstone allocation for backup oxygenation system for raceways.

CFM = 100 cfm across 8 raceways
twenty five each, 1.5 x 1.5 x 6" airstones at 0.5 cfm each, per raceway
Airstones = twenty five per raceway at 0.5 cfm each flow rate

AIR ALLOCATION (NURSE BASINS)

Nurse Ponds-30,000 fish = 7,500 fish/pond assuming no mortality for modeling
7,500, Six inch fish at maximum density (65 grams/fish)
Holding time = 6 months in Nurse Basins
Final Loading Density = 4290.40 pounds = 1950.20 kg

$Y = 0.001(W)^{0.82}$

$Y = 0.001(65)^{0.82}$

$Y = 0.031$ grams O_2/fish/hour x 30,000 fish

$Y_T = 930$ grams O_2/hour

$Y_{day} = 22,320$ gms O_2/day = 49.10 pounds O_2/day

$Y_{day} = 49.10$ pounds x 1.5 B.O.D. correction factor
73.50 pounds O_2 total

O_2 allocation/nurse pond = 18.375 pounds O_2

WATER FLOW FOR FISH O_2 DEMAND (NURSE BASIN)

The following water flow rates have been established based upon flow needed to support given maximum densities with an inflow dissolved oxygen of seven milligrams per liter.
349 grams/nurse pond/hour is fish O_2 consumption
Incoming water DO design = 7 mg/l minimum
Flow/Nurse Pond at maximum density to maintain biomass as given
250 gpm x 3.785 x 7 mg/l DO/1000 = 397.4 grams O_2/hour
Allocate a total of 1000 gpm recirculation for the four nurse basins or 250 gpm per nurse basin to supply normal oxygen needs of fish.

AERATION BACK-UP SYSTEM

$$\text{Air/Nurse Basin} = \frac{73.50 \text{ pounds } O_2}{1440(0.075)(0.232)(0.125)}$$

Cfm = 73.50/3.13, where cfm = Cubic feet per minute

CFM/Nurse Basin = 24 cfm minimum
Airstones for pond distribution for Nurse Basins Twenty four x 0.2 cfm 1.5 x 1.5 x 3" airstones One hundred twenty airstones/nurse ponds = Four hundred eighty total

BROOD PONDS

Broodstock mentioned here are for reference purposes only, and will not be addressed in detail until the final design stage. Broodstock ponds noted on the preliminary design represent future development only.

A flow of 80 gpm has been allocated for each brood pond plus continuous aeration to meet oxygen requirements of the broodstock.

Fifty each, 1.5 x 1.5 x 6" airstones will be utilized to provide extra oxygen and backup to the brood ponds in the event of recirculation failure. Up to a maximum of 25 cfm per brood pond is allocated to provide ample dissolved oxygen and compensate for variable loading densities that may be required for pairing of broodstock.

Projected B.O.D. and Ammonia Removal System for Raceway, Brood and Nurse Basins

The use of large-surface area (one acre) wastewater treatment basins, provide long turn-over time and are very effective in complete nitrification, SS removal and BOD_5 reduction.

Three, one acre wastewater treatment ponds (3.5 feet average depth) with a total volume of 3.44 mg (1.15 mg per treatment pond) are incorporated into the recirculation loop. The wastewater treatment ponds are designed for complete water reconditioning prior to recirculation to provide high quality water to fingerling fish.

Aeration is applied to the lagoon at a rate sufficient for B.O.D.(biological oxygen demand) reduction and nitrification. The system is sized to accommodate a total loading of 10,000 pounds across the upper system to include fingerling grow-out and brood fish holding. Life support calculations provide for twice the normal loading density and provide ample room for expansion of fish stocks as well as a 100% safety margin.

Large safety margins we feel are appropriate when dealing with endangered species and the potential loss of fish stocks.

Oxygen requirement for total water treatment per pound of B.O.D. applied are based upon 10,000 pounds maximum sustainable biomass across the system for all sizes and densities of fish.

B.O.D. and ammonia reduction rates are based upon the following criteria for Pond Treatment waste water systems. Applied oxygen consumption rates in the treatment ponds are as follows:

A. B.O.D. = 1.5 pounds O_2/1 pound B.O.D. applied from fish waste, (B.O.D.=biological oxygen demand)

B. Nitrification = 0.30 pounds O_2/pounds B.O.D.

C. Benthic Demand = 0.40 pounds O_2/pound B.O.D.
D. Aerobic sludge = 0.05 pounds O_2/pound B.O.D.
Total = 2.25 pounds/O_2/pound B.O.D. applied

B.O.D. reduction estimates are based upon total load to treatment ponds from fish at maximum loading of 4,545.50 kilograms across the system. 1.34 kg B.O.D./100 kg fish at full feeding (represents the average B.O.D. production)
4545.50 kg fish/100 x 1.34 kg = B.O.D. applied
Total B.O.D. = 60.91 pounds*
60.91 x 2.25 O_2 = 137.05 pounds O_2/day
for breakdown of all nitrogenous wastes, B.O.D. and VAS(variable suspended solids)

Lagoon One Aeration

The following formula is used to calculate cubic feet per minute (CFM) air requirement for air stones at 3.5 foot submergence with a given field transfer rate efficiency of fifteen per cent.

A diffused air system utilizing 1.5" x 1.5" x 3" glass bonded silica airstones on floating manifolds supply the total air needs for B.O.D. reduction in treatment lagoon number one. Thirty six cfm will be applied to lagoon one to provide 137.05 pounds per day to oxidize 60.9 pounds of applied B.O.D.

Lagoon number two will not be aerated and will be utilized for polishing and nitrification clarification. Lagoon three is the final treatment pond for water reconditioning and re-aeration. Two mechanical aspirating aerators will be used to maintain a constant seven milligrams per liter oxygen level as water is fed to the pumpback system.

$$\text{CFM Air} = \frac{137.05}{1440 \times 0.075 \times 0.232 \times 0.15 \text{ FTR}} - \frac{137.05}{3.758} = 36$$

CFM air Lagoon #1 = 36 cfm constant aeration (diffuse aeration)
Lagoon #2 = Polishing only / Nitrification (no aeration)
Lagoon #3 = Re-aeration and final water reconditioning
Recirculating pumping rate for maximum biomass is set at 1800 - 2100 gpm (2.88 mad), resulting in a turnaround (Residence Time) for water of 1.19 days in the treatment pond system. Calculations assume no plate filter in line, which offers a substantial margin of safety. The plate filter in line, which offers a substantial margin of safety. The plate filter can remove at least 50% of the B.O.D. and 80% of TSS prior to the water reaching treatment lagoon #1. Calculations here are based upon no removal of solids prior to the treatment ponds, allowing a large safety margin for the nitrification system.

Two, two horse power aspirating aerators will be used to re-aerate and circulate treatment pond number 3, prior to water being pumped back to the distribution / re-aeration head box. (See lagoon layout drawings). The aerators deliver an oxygen transfer rate efficiency of 2.0 pounds oxygen per horsepower per hour. Aspirating aerators are effective in providing complete pond recirculation. The purpose of the aerators are to provide re-aeration and deliver saturated water to the sump area for recirculation to raceways, nurse basin and broodstock ponds.

LOWER REARING POND SECTION (Growout Pond System)

The lower rearing section consists of twelve each, on half acre rearing ponds. Each pond has a dimension of 104 feet x 209 feet x 3.5 feet depth with a volume of 570,500 gallons of water. It is projected that a total of 24,000, 6" fish will be transferred to the 12, 1/2 acre rearing ponds. Fish are on grown here for 12 months before distribution. Approximately 1500 razorback suckers will be planted in each rearing pond. Calculations concerning flow and aeration are based on final weights at 15" and 2.85 pounds (1298 grams) as described in the Hualapai and Bureau of Reclamation Feasibility Study of July 7, 1994 as final average weight for *Xyrauchen texanus*.

Final standing crop per pound could range from 4275 pounds - 5625 pounds per rearing pond, accounting for individual variability in growth.

Grow-out Ponds

Grow-out ponds react differently than smaller ponds or raceways with plugged volume flow characteristics, therefore, flow rates based upon 6 gpm per pound of feed fed are not practical in calculating oxygen requirements. In this case, constant mechanical aeration, water flow, exchange rates and natural processes of aeration must be relied upon to provide sufficient aeration in grow-out pond situations.

A combination of the above serve to provide ample oxygen for algal night time respiration, B.O.D. and fish respiration oxygen demands. Phytoplanktonic algal processes in large ponds tend to maintain low unionized ammonia levels through absorption and metabolic processes.

Aeration rates of 50 - 60 cfm per rearing pond are suggested to maintain sufficient oxygen levels based upon data from intensive rearing facilities. Fifty cfm is adequate to handle fish respiration, benthic demand and algal respiration for five thousand six hundred pounds maximum loading density.

A flow of 125 gpm per pound will replace thirty per cent of total pond volume per day, an adequate turnover rate for reconditioned recirculating water, which can be as low as ten percent per day.

A maximum holding density of 0.075 pounds per cubic foot was chosen for larger fish in the grow-out pounds. This stocking density is well within reasonable limits and only 1/40 of stocking densities found under normal production conditions.

A total recirculating volume of 2000 gpm is required for the grow-out ponds to provide 125 gpm (gallons per minute) per pond.

AERATION REQUIREMENTS (Growout Ponds)

<u>1/2 Acre Ponds (Air requirements)</u>
60 cfm per pond

Total air requirement	=	800 scfm
Airstones per pound	=	300 each 1 1/2 x 1 1/2 x 3" at 0.2 cfm air flow each
Aeration layout	=	Floating manifold system consisting of 3 lines each with 100 airstones spaced equidistance for aeration coverage.

Aeration - Nitrification for Treatment Pond (Grow-out Pond Unit)

The nitrification pond design for the growout pond consists of one large aerated lagoon system 209 feet x 522 feet.
B.O.D. reduction estimates for the treatment lagoon are estimated as follows:
1.34 kg/B.O.D. per 100 kg fish at full feeding
5600 pounds of fish per pound = 2,546 kg per pond
2456 x 1.34 kg B.O.D. = 3411 - 100= 34.11 pounds B.O.D. per pound per day at maximum density
34.11 x 16 pounds = 545.76 pounds B.O.D. applied per day
545.76 x 2.25 O pounds B.O.D. = 1228 pounds O per day to reduce nitrogenous wastes and B.O.D.

$$\text{Cfm air} = \frac{\text{1228 pounds oxygen}}{1440 \times 0.075 \times 0.232 \times 0.15 \text{ FTR} \quad 3.758} \qquad \underline{1228}$$

Cfm = 324 air for lagoon system

Airstones = One thousand six hundred twenty two each 1 1/2 x 1 1/2 x 3" to achieve B.O.D. reduction and represents the total number of airstones to deliver 324 cfm of air at the given transfer rate efficiency of fifteen percent.

GROWOUT TREATMENT PONDS, WATER FLOW REGIMEN

Return water from the sixteen rearing ponds exit each pond and is routed to a common manifold via the drain piping. The common manifold carries water through the plate filter, then overflows from the plate filter and enters the 2.5 acre treatment pond. Solid wastes from the plate filter are backwashed to a small holding lagoon for further treatment of disposal.

Nitrogenous wastes are broken down by backwashed to a small holding lagoon for further treatment or disposal.

Nitrogenous wastes are broken down by bacterial action and algal absorption. Aeration required has been calculated for maximum loading densities, assuming all waste reaches the ponds, excluding the plate filter. Again, adding a certain degree of safety in the protection of brood stock. A turnover time of approximately one day, 2.88 mad (million gallons per day) is realized at the full recirculation rate of 2000 gpm for the water treatment lagoon. Volume of the treatment lagoon is approximately 2.86 mg (million gallons), with dimensions of 209 feet x 522 feet x 3.5 feet deep.

SUMMARY

Information contained within this section is very preliminary in nature and is not intended to represent the final design or specifications for certain or exact equipment. The system overview presented here is not intended to address detailed expected operation, maintenance, and replacement costs for the hatchery until later phases of the study.

The Santa Fe well site is located on the Hualapai reservation at elevation 5,924 feet above sea level. The site was intended to propagate razorback suckers under natural growth conditions without a supplemental heating or auxiliary heat source. If advanced growth of fingerlings are desired, this could be accomplished in an indoor hatchery environment and can be addressed during the next phase of the engineering study. Recirculatory indoor technology can be very effective in advancing fingerling growth for later release to the outdoor system or in the maintenance of broodstock under controlled conditions.

Budgetary constraints on this phase of the project did not allow for any full scale engineering design, specifications or detailed projections for cost accounting. Many of these questions can be answered during the next study phase if budgetary requirements can be allocated for detailed engineering analysis.

Considering the limited availability of water at the Santa Fe site, approximately 50 gpm - 70 gpm, it would be most appropriate to consider indoor intensive aquaculture technology as an alternative to the outdoor system. Not only is much less water needed, but an intensive recirculating system may be used for a variety of commercially viable species in the future. Under the scenario there is sufficient water available for expansion of indoor facilities up to 1,000,000 gallons of system tankage.

Indoor aquaculture produces the following advantages:

1. Year round production of razorback suckers
2. Advanced fingerling growth
3. Eliminates predator problems
4. Allows for controlled spawning and broodstock development.
5. Controlled temperature environment for maximum production on a year round basis.
6. Exact control of fish numbers and decreased mortality.

There are many advantages to controlled intensive aquaculture systems over outdoor pond systems, especially when dealing with endangered species where the survival of each individual fish can be critical. Keeton industries, Inc. would suggest that intensive indoor recirculating technology be thoroughly investigated in the next project phase.

Past experience indicates that an indoor system to accomplish the same goals and volumes as the outdoor system can be constructed for the same price, with much reduced water usage and superior control of water quality and environmental conditions.

PRELIMINARY EQUIPMENT COST ANALYSIS

1.	Oxygenation Equipment Custom fabricated 20" multi-stage Oxygen concentrator 4 each @ 3,020.00	12,080.00
2.	Ozone disinfection and re-aeration System for both pump stations 7 lamp stainless steel ozonators with refrigerated air dryers, pumps and all accessories	31,796.00
3.	AirSep Oxygen Generators AS-80 Oxygen generators rated at 80 SCFH with all controls, compressor and surge tank 2 each @ 13,425.00	26,850.00
4.	Liners for Brood Ponds, Nurse Ponds, Treatment Ponds and Grow-out Ponds 800,000 square feet of liner plus pipe boots on site, inspection prior to installation, on site supervision, on site welding of liners	283,000.00
	Site work - land leveling	91,000.00
5.	Electrical	65,000.00
6.	Back-up Generator with auto start controls	40,000.00
7.	Pumping System Stations #1 and #2 foot valves, 4 each 40 horsepower centrifugal pumps to deliver 2000 gpm	

	at 50 feet of TDH Distribution manifold	28,000.00
8.	Intensive aeration system for ponds, raceways, brood ponds, nurse ponds, treatment system and grow-out ponds	45,000.00
9.	Blowers air station, cooling manifold	12,000.00
10.	Raceways	45,000.00
11.	Engineering Project Costs	75,000.00
12.	Miscellaneous aquaculture supplies	10,000.00
13.	Incline Plate Filters	25,000.00
14.	Pump houses	4,000.00
15.	Blower buildings	4,000.00
16.	Piping and fittings all PVC, valves etc. (See detailed pipe specification sheets)	277,703.00
17.	Automatic Solar Powered Feeders 36 each @ 800.00	28,800.00
18.	Other site work - construction costs	20,000.00
19.	Monitoring Systems	8,000.00
20.	Aspirating Aerators with starters, controls and power cables 2 each 3,000.00	6,000.00
21.	Misc. project expenses (i.e. travel, per diem)	25,000.00
	PROJECT TOTAL COSTS	**$1,163,229.00**

V. ESTIMATED CAPITAL AND OPERATING/MAINTENANCE COSTS FOR PHASE II FACILITY CONSTRUCTION

It is estimated the total project costs will require $1,163,229.00 (See Section IV). Operation and Maintenance Costs for FY1996 are estimated at $420,400.00 (See Below).

Total costs for FY1996 are $1,583,629.00.

DRAFT FY1996 HUALAPAI
ENDANGERED FISH REARING FACILITY
OPERATION & MAINTENANCE BUDGET *

DESCRIPTION FY1996 BUDGET	
Total Budget	$420,400.00
Facility Manager	$32,000.00
Fishery Biologist	28,000.00
2-Fish Culturist Trainee	29,120.00
Salaries & Wages	89,120.00
Fringe @ 25%	22,280.00
Feed/Chemicals	10,000.00
Utilities	15,000.00
Operating Materials/Supplies	5,000.00
Professional Services/Cas. Labor	5,000.00
Consulting Services	5,000.00
Postage	1,000.00
Insurance	1,500.00
Telephone	2,000.00
Office Supplies	5,000.00
Travel	4,000.00
Gas/Oil	3,000.00
Vehicle Repairs	2,500.00
Equipment (4X4 Vehicle, Used Backhoe)	100,000.00
3-Mobile homes and security fence	150,000.00
Total Budget	$420,400.00

*** Estimate based upon Dexter National Fish Hatchery and Technology Center FY1993 Actual Expenditures.**

VI. BROODSTOCK ACQUISITION

At this time, we will not attempt to implement a broodstock program because of concerns regarding the ramifications of the genetic composition of the broodstock.

VII. FINGERLING ACQUISITION

30,000 razorback sucker fingerlings in the range of 2-3 inches will be supplied by the Dexter National Hatchery at Dexter, New Mexico (DNFHTC). They will be transported via hatchery truck and delivered to the Endangered Fish Rearing Facility located on the Hualapai Reservation. Although fingerlings could be collected from Lake Mohave.

VIII. PROGRAM OPERATIONS

This section will briefly describe program operations from the construction phase to the initial stocking of fish. Assuming full funding, construction of the entire facility should take one year. Natural Resource staff including construction crew will be utilized during the construction phase. The raceway work will be contracted out. All other pond construction will be completed by utilizing our own construction crew.

30,000 2" to 3" fingerlings already approximately 6 months old will be stocked into the 8 raceways and reared for approximately 6 months to about 6" to 7". The fish will then be transferred to the four, quarter-acre ponds for another 6 months. Because this will occur during the fall and winter we assume little or no growth during this period. The fish will then be transferred to the 12 half-acre ponds. This is the final stage of rearing which is projected to produce 15 inch fish in 12 months. This whole process, will therefore consume two years for the production of 15 inch fish at the facility.

Table 2. Summary of Production Numbers for Razorback Suckers.

Stage	# Fish In	# Fish Out	Size In	Size Out	Rearing Time
Raceways	30,000	25,000	2"-3"	6"-7"	6 Months
Nurse Ponds	25,000	22,500	6"-7"	7"-8"	6 Months
Grow Out Ponds	22,500	20,100	7"-8"	15"	12 Months

The fish would then be stocked at pre-selected release sites.

It is anticipated the facility will be staffed by four full-time employees in the first two years of operation. Two of these employees will need to live on site to allow for 24hr maintenance and security.

IX. POTENTIAL RAZORBACK RELEASE SITES AND PROCEDURES

We have examined the following tributaries for suitability as reintroduction sites. To date, we have collected information regarding the quantity and quality of the waters flowing from the springs creating these tributaries. This information will be provided here for each area. In general the most suitable site for release would be Spencer Creek due to its size and the size of fish being released.

To further investigate potential release sites we created a proposal which examines habitat utilization and the overall stocking success. This proposal in found in section XIV.

Table 3. Water quality and quantity results for potential reintroduction sites summary for Razorback Suckers, collected May of 1993.

LOCATION	CFS	GPM	H20 TEMP.	CNDCTNCE	pH	DO	Alk.,HCO3
Spencer Creek	6.5	5,000	23.0 C	706	8.3	7.7	326
Diamond Creek	0.55	248	21.9 C	454	8.3	7.1	211
Lost Creek	2.5	1,050	24.5 C	680	8.2	7.3	332

Procedurally, we will transfer fish from the one-half acre rearing ponds using standard protocols. These protocols include proper monitoring and management of stress, oxygen requirements, anesthetics if necessary, temperature acclimation, and transfer procedures.

X. BIOLOGICAL NEEDS, CLIMATIC CONDITIONS, GROWTH MODELS

Biological Needs and Climatic Conditions

The following information has been supplied by the Dexter Hatchery or is taken directly from Wydoski (1994).

Feeding Rates

Feeding rate can be calculated in percent of body weight per day based on expected growth at a given water temperature and adjusted at five-day intervals. The food required is calculated by multiplying the percentage of body weight per day by the weight of the fish in pounds. The following formula can be used to determine the percentage of body weight per day:

> Percent body weight per day = 30-day growth in inches times the food conversion factor times 10, divided by the length of the fish in inches.
>
> As fish double in length (as an average per cohort), the weight of the food required per pound of fish is reduced by one-half. Therefore, the food requirement per pound of fish is inversely proportional to the length of the fish.

Dissolved Oxygen

The oxygen content of water is affected chiefly by the temperature of the water and the partial pressure of the gas. Respiration of the fish, however, and biological oxygen demand due to the processing of metabolic wastes are also important. Additionally, as the temperature increases from 50 to 77 degrees F, the metabolic rate of endangered Colorado River fishes increases proportionally thereby increasing the oxygen demand. The loading rate of fish and the feeding rate are also critical to oxygen consumption by fish and the biological oxygen demand of metabolic wastes. The proposed minimum dissolved oxygen in parts per million (= mg/l) is 4.0 for inflow water. The water flow required with different inflow DO levels per pound of food fed to fish daily is given below (from Wydoski 1994).

Table 4. Water flow requirements for fish rearing facilities at various dissolved oxygen levels per pound of food fed daily to fish.

Dissolved Oxygen (ppm)	Available Dissolved Oxygen per 1.0 gpm for metabolism of food (PPM)	Available Dissolved Oxygen per 1.0 gpm for metabolism of food grams/day	Water Flow Required gpm/lb. of food	Water Flow Required gpm/100 grams of food
4.0	0	0	No Food	No Food
4.5	0.5	2.7	55	12
5.0	1.0	5.4	28	6
5.5	1.5	8.2	18	4
6.0	2.0	10.9	14	3
6.5	2.5	13.6	11	2.4
7.0	3.0	16.3	9	2.0
7.5	3.5	19.0	8	1.8
8.0	4.0	21.8	7	1.5
8.5	4.5	24.5	6	1.3
9.0	5.0	27.2	5.5	1.2
9.5	5.5	29.9	5.0	1.1
10.0	6.0	32.6	4.6	1.0

Nitrogenous Waste

One of the main by-products of fish metabolism is ammonia. Some of the ammonia dissolves to form ammonium ions while the majority remains as unionized ammonia. Unionized ammonia is toxic to fish. The concentration of this chemical increases with increasing pH and temperature. Therefore, as the pH and temperature increase, the amount of water flow must also increase to reduce the ammonia concentration. Unionized ammonia becomes toxic at a concentration of 0.0125 ppm.

A minimum flow of 6 gallons per minute is required per pound of food that is fed daily to reduce the concentration of unionized ammonia. This flow recommendation is based on the assumption that the pH is between 7.5 and 8.0. Less flow is required for lower pH values and more flow is required at higher pH levels. The flow required at various dissolved oxygen levels is given in Table 4 above.

Condition Factors

A condition factor (C) is calculated by dividing the weight of the fish (W) in pounds by the cube of its total length (L) in inches. Condition factors that are acceptable for the Razorback Sucker and Humpback Chub are 4.5 and 4.0 respectively (Wydoski 1994). Condition factors will be calculated for a subsample of each cohort at various times during their development.

Growth Models

The average water temperature during the growing season in pre-dam times in the upper Colorado River Basin was estimated by Wydoski (1994) to be approximately 70 degrees Fahrenheit. This study estimated that the growing season for the first year was less than for successive years because of the spawning season. Growth was assumed to cease at temperatures below 50 degrees Fahrenheit, and it was found that the fish would grow at a constant rate until sexual maturity (Wydoski 1994). This growth rate at 70 degrees F was 0.75 inches per month. Below we provide the findings of Wydoski (1994) regarding razorback sucker growth models.

Table 5. Average number, total length and weight of razorback suckers from one paired mating at the end of each growing season until the fish reach sexual maturity (from Wydoski 1994).

Category	End of Growing Season 1	2	3	4	5
Number of Fish	500	250	200	160	152
Average Total Length in inches	3.5	7.25	11.0	14.8	18.5
# of Fish/pound	51	5.8	1.7	0.7	0.35
Total Weight (lbs)	9.8	43.1	118	232	434

Density

The density of fish, in pounds, that an be reared in a cubic foot of rearing space is estimated by dividing the total length of the fish in inches by 2. For example, 1 pound of 2-inch fish can be reared in one cubic foot of water. Similarly, two pounds of 4-inch fish can be reared in the same volume because their metabolic rates are less (Wydoski 1994).

Climatic Conditions

While the natural climatic conditions that the native fishes of the Colorado River experienced in pre-dam times was that of warm, turbid waters, the water supplying the proposed fish-rearing facility on the Hualapai Reservation will be cool, clear water. To alleviate potential impacts of solar radiation, we will inoculate the waters of the facility with appropriate algal species to reduce solar radiation and provide cover for the fish. Additionally, we will implement aeration and recirculation systems. See Section IV.

XI. NEPA COORDINATION

The Hualapai Tribe has initiated coordination among tribal, state, federal and private agencies for NEPA compliance by summoning representatives from the appropriate entities for a feasibility assessment meeting. This meeting was held 6/17/94 in Peach Springs, Arizona and was attended by the following individuals:

NAME	ORGANIZATION
Mr. Don Bay	Hualapai Tribe
Mr. Tom Burke	BOR-Lower Colorado Region
Dr. Steve Carothers	SWCA Environmental Consultants
Dr. Kerry Christensen	Hualapai Tribe

Mr. Brice Hoskins	SWCA Environmental Consultants
Mr. Dennis Kubly	Arizona Game & Fish
Mr. Bill Leibfried	Leibfried Envtl. Services
Mr. Chuck Minckley	U.S. Fish and Wildlife Service
Dr. Richard Valdez	Bio/West, Inc.
Mr. Dave Wegner	BOR-GCES
Mr. Ben Zimmerman	Hualapai Tribe

The work group advocated the preparation of a feasibility report (this document) and preparation of an Environmental Assessment (EA) document upon approval of the project by the Hualapai community. A copy of the EA document is appended to this report to demonstrate the level of NEPA compliance to date. The Tribe will continue to coordinate with the Bureau of Reclamation and other agencies to achieve NEPA compliance.

XII. CULTURAL SURVEY

On 6/21/94, Cultural Resource personnel from the Hualapai Department of Natural Resources conducted a cultural survey of the proposed project site. As a result of this survey, it was concluded that construction of an Endangered Fish Rearing Facility at the Santa Fe site in the Frazier Wells area might not have a significant impact on cultural resources. The concurrence letter from the Arizona State Historical Preservation Office and can be found in Appendix C.

XIII. THREATENED AND ENDANGERED SPECIES SURVEY

A survey of the proposed project site was performed on 6/24/94 by members of the Department of Natural Resources of the Hualapai Tribe. No Threatened or Endangered plants or animals were observed during this survey. There is potential for Peregrine Falcons and Bald Eagles to fly through the area, but construction of an Endangered Fish Rearing Facility will not significantly impact any threatened or endangered species.

We have also contacted the U.S. Fish and Wildlife Service in Phoenix, Arizona and have requested a list of Threatened and Endangered Species that may occur in the region. The following plants were identified by the USFWS as being in the area. We surveyed for these plants but were unable to locate any individuals. A copy of the concurrence letter from the Service can be found in Appendix D.

XIV. TASK STATEMENT AND BUDGET DISTRIBUTION

The following tasks must be completed prior to FY1996 and the beginning of Phase II Facility Construction.

1) Coordination with USFWS in regards to the issuance of a refugia permit for the facility.
$9,055.31

2) Implementation of "An Evaluation of a Reintroduction/Stocking Program for the Hualapai Endangered Fish Rearing Facility. (see below)
$38,944.69

3) A study to analyze the groundwater hydraulics of the Frazier Wells area. (See below)
$2,000.00

4) Seeking additional funding.

Reintroduction of Razorback Suckers into the Grand Canyon: An Evaluation of a Reintroduction/Stocking Program for the Hualapai Endangered Fish Rearing Facility

Hualapai Indian Reservation, Mohave County and Coconino County

Purpose and Need:

In order to implement a successful reintroduction/stocking program of razorback suckers (Xyrauchen texanus) into the Grand Canyon, studies are needed to determine their release behaviors responses and habitat requirements. We therefore plan to stock 15 adult suckers, greater than 550 grams, into the Grand Canyon, within the boundaries of the Hualapai Reservation. These fish will be equipped with radio tags and monitored intensively for four months by radio telemetry. With this information, we hope to gather valuable information on movements, survival, activity patterns, and factors that may enhance the reintroduction success.

Objectives:

1. Evaluate factors affecting the success of reintroducing razorback sucker into the Grand Canyon within the boundaries of the Hualapai Indian Reservation.

2. Gather information of movements, survival and activity patterns.

3. Evaluate habitat use versus availability.

4. Evaluate growth and condition of captured individual

razorbacks.

5. Provide recommendations for future stocking and reintroduction efforts.

Time Table of Research Activities and Deliverables:

May-June 1995	Obtain necessary permit from U.S. Fish and Wildlife Service for a "experimental population" of endangered species. Purchase telemetry equipment, radio tags, and other supplies.
July 1995	Acquire 15 adult razorback suckers from Dexter National Fish Hatchery. Transport fish to Diamond Creek where fish will be implanted with radio tags and then transported to Spencer via 22' snout boat, with 400 gallon holding tank.
August-November 1995	Begin a series of monitoring trips to assess location and habitat preferences of razorback suckers. Two trips per month: One survey/location trip and one intensive observation trip of fish for 24-48 hours: mapping movements on mylar overlays of aerial photos.
December -1995	With the use of the telemetry equipment attempt to recapture suckers via trammel nets to access growth and condition.
January - 1996	Prepare preliminary draft for review and comment of various agencies and professionals.
March - 1996	Prepare and submit final report.

Budgetary Requirements for Reintroduction Project:

	Hours		Cost	Total Cost
Personnel/Labor:				
SWCA Inc.	426	$42.00	17,892.00	17,892.00
HNRD Personnel	506	$14.93	7,556.36	7,556.36
Report Preparation:				
SWCA Inc.	48	$42.00	2,016.00	2,016.00
HNRD Personnel	51	$14.93	761.43	761.43
Equipment:				
2-Receiver (ATS Model 2000)			2,000.00	4,000.00
2-Antennas (Omni-directional Larsen-Kulrod whip)				

	90.00	180.00
2-Antennas (Smith-Root loop)	90.00	180.00
15-Radio Tags, 11 grams	165.00	2,475.00
Supplies:		
Surgical Supplies		600.00
Office Supplies		300.00
Gas & Oil:		600.00
Food & Related Supp.		700.00
Indirect Costs @ 16.01% (Less Equipment and Consultant)		1,683.90

*The HNRD will supply boats, vehicles, camping gear associated with the project needs.

Total Cost of Project 38,944.69

Project Personnel:

Bill Leifried of SWCA Inc. will act as the project manager for the proposed study. He has extensive experience in telemetry of humpback chub within the Grand Canyon (See attached Resume) in addition to the experience he has gained working on numerous fisheries related projects in the Grand Canyon.

Ben Zimmerman, in addition to other Hualapai fisheries technicians, will assist Mr. Leifried throughout the project. They are well qualified for these reasons: (1) Mr. Zimmerman, who earned a Bachelor of Science degree in Fishery Biology, and the Hualapai Natural Resource Technicians have been studying native fishes in the Grand Canyon as part of the GCES project for the past two years, and (2) these personnel have extensive experience running the river and hiking these tributaries so they can easily implement the project. The resume of Mr. Zimmerman is also attached.

Detailed Study Design:

May-June 1995. During the months of May through June, a permit for an "experimental population" of razorback suckers will be obtained from the U.S. Fish and Wildlife Service for the acquisition of the 15 adult sucker. Final plans will be worked out with Dexter National Fish Hatchery.

July 1995. During the month of July the HNRD staff will meet Dexter personnel at some predetermined location, somewhere in Arizona, to pick up razorback suckers. From that point the HNRD staff will transport these fish to Diamond Creek where project personnel will be waiting to surgically implant 11 gram radio tags. These fish will also be implanted with PIT tags for future identification of individual fish. The suckers will then be held for 6 hours and then transported by 22' snout boat on the Colorado River to Spencer Creek, Rm 246. Five (5) suckers will be stocked into Spencer Creek about 1.5 miles from the river, five (5) fish planted at the mouth of Spencer, and five (5) fish planted within two miles of the mouth of Spencer Creek in the main channel.

August-November 1995 Project personnel will begin a series of monitoring trips to access location and habitat use of the 15 adults. Two trips per month will be planned to map these locations which will be placed on mylar overlays using 1:1200 or 1:2400-scale aerial photograph. Habitat measurements will taken at each location which include depth, velocity, substrate, temperature, overhead cover, and lateral structure (Valdez, R.A., and M. Hugentobler (editors). 1993). In addition other water quality measurements will be taken such as dissolved oxygen, pH, conductivity, and turbidity.

December 1995 With the use of telemetry the project personnel will locate and attempt to capture the adults sucker to monitor growth and condition.

January 1996 A preliminary draft will be prepared consisting of movement maps, habitat characteristics, growth, diet and discussion on where stocking sites should be located. Reports will be sent to various agencies and professional for review. We will require comments to be submitted by February 15, 1996, allowing 4 weeks for comments and review.

February-March 1996 After comments have been received and complied and a final draft will be submitted by March 15, 1996.
We will incorporate findings of the study into the stocking plan for the Endangered Fish Rearing Facility.

Coordination with other Agencies:
The following agencies will receive and have the opportunity to make comments on the draft and final report:

* Arizona Game and Fish Department
* United States Fish and Wildlife Service
* Bureau of Reclamation
* Lake Mead National Recreation Area
* Grand Canyon National Park

FRAZIERS WELL GROUNDWATER HYDRAULICS STUDY

GOAL: Determine safe yield of basin

APPOACH: 1) Review all available Fraziers Well Data
2) Measure water levels: Fraziers Well will be pumped; two well to SE will be observation wells
3) Check pipe size for flow meter

4) Purchase flow meter
5) Measure distances between wells
6) Run pretest from one to two hours
7) Design most appropriate test to evaluate basin

EQUIPMENT REQUIRED:
1) Water Level sounders
2) Measuring Tapes
3) Measuring Chains
4) Flow measuring meter
5) Topo maps
6) Semi-log graph paper
7) Pump test forms
8) Gate Value
9) pH - conductivity meter
10) Flashlight
11) Watch

XV. BUDGET REQUIREMENTS

In order for the Hualapai Tribe to construct, operate and maintain the proposed rearing facility as originally conceived it will require a initial capital investment of $1,583,629.00. Consequently we were informed that what was available by BOR is $300,000.00 in FY1996 an $400,000.00 in Fy1997 about a month ago.

We feel that it is still possible to begin Phase II construction by altering the timing to reflect the current budget constraints.

Budget Requirements for the remainder of FY1995 is $50,000.00 to complete the tasks listed in Section XIV.

XVI. REQUEST FOR ACTION

We request a modification to the current contract and a additional allocation of $50,000.00 for Fy1995.

XVII. LITERATURE CITED

Barneby, R.C. 1964. Atlas of North American Astragalus, Part II. New York Botanical Garden, Bronx, New York.

Boyer, D.G. and Ince S. 1978. Water Resources Development Study for the Hualapai Indian Tribe. A Report of Work Under Bureau of Indian Affairs Technical Assistance Contract #50C14200225.

Burke, T. 1994. Lake Mohave Native Fish Rearing Program. Prepared and Presented by Thomas Burke, Fishery Biologist, Bureau of Reclamation, Boulder City, Nevada. 23 page Report.

Dexter National Fish Hatchery and Technology Center Station. Annual Report, Fiscal Year 1993, Dexter, Nex Mexico.

Hendrickson, D.A. 1993. Evaluation of the razorback sucker (Xyrauchen texanus) and Colorado squawfish (Ptychochelius lucius) reintroduction programs in central Arizona based on surveys of fish populations in the Salt and Verde rivers from 1986 to 1990. Nongame and Endangered Wildlife Program Report. Arizona Game and Fish Department, Phoenix, Arizona. 166pp.

Johnson, J.E. and B.L. Jensen. 1991. Hatcheries for Endangered freshwater fishes. In: Battle Against Extinction: Native Fish Management in the American West, W.L. Minckley and J.E. Deacon eds., University of Arizona Press. P. 199-217

Kime, K., Van Pelt, and Belitsky. 1992. Status of the Hualapai Mexican Vole in Northwestern Arizona. Arizona Game and Fish Department Publication.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. Museum of Northern Arizona Publication. Flagstaff, AZ

Minckley, W.L. and James E. Deacon. 1991. Battle Against Extinction, Native Fish Management in the American West. The University of Arizona Press.

Rutman, S. 1992. Handbook of Arizona's Endangered, Threatened and Candidate Plants. U.S. Fish and Wildlife Service. Phoenix, Arizona.

U.S. Fish and Wildlife Service. 1992. Endangered and Threatened Species of Arizona. Phoenix, Arizona.

Valdez, R.A., and M. Hugentobler (editors). 1993. Characterization of the life history and ecology of the humpback chub (Gila cypha) in the Grand Canyon. Annual Report-1992 to Bureau of Reclamation, Contract No. 0-CS-40-09110. BIO/WEST Report No. TR-250-06. 168 pp + appendices.

Williamson, J. H. and R.S. Wydoski. May 25, 1994. Genetics Management Guidelines. Recovery Implementation Program For Endangered Fishes in the Upper Colorado River Basin. USDOI, Fish and Wildlife Service, Denver, Colorado.

Wydoski, R.S.. May 25, 1994. Coordinated Hatchery Facility Plan: Need for Captive-Reared Endangered Fishes and

Propagation Facilities. Recovery Implementation Program For Endangered Fishes in the Upper Colorado River Basin. USDOI, Fish and Wildlife Service, Denver, Colorado.

Appendix A

Pump and Draw Down Test From Universal Drilling Inc.

UNIVERSAL DRILLING INC.

Waterwell & Exploration Drilling

Steve Roberts & Doug Roberts

The Professionals

BOX 593 Yarnell, Arizona 85362 (602)427-3363 Yard

BOX 1027 Wickenburg, Arizona 85358 (602)684-2886 Office

A4-072978

Mr. Don Bay
Hualapai Wildlife Management
P.O. Box 300
Peach Springs, Az.
86434

June 16, 1993

Ref: Pump & Draw Down Test. Well # 2 (Fraisers Wells)

Rig Travel Time (2 Trucks 4 hrs one way) 16 hrs	$ 800.00
Per Diem 2 men $ 35 per day per man	140.00
Installation of Equipment: Had to pull existing pump and install test pump 3.5 hrs	227.50
Test pumping of well: start time 11:30 am June 9 end 6:30 am June 10 (had to extend test due to water not stabilizing) 19 hrs	1425.00
Pull test pump and return original pump. (pump was pulling high amps when we arrived due to bad cable. We spliced in new, returning it to normal)	200.00
Total	$ 2792.50

Static water level 51 feet
Total depth of well 130 feet
Set test pump 112 feet
Estimate gallons per minute 71

Thanks

Doug Roberts

Doug Roberts

DATE 6-9/93
6-10/

PAGE 1

UNIVERSAL DRILLING & WICKENBURG PUMP

TIME	WATER LEVEL	GPM
11:30 Am	51'	83
12:00	73'	75
1:00	74'	75
2:00	75'	75
3:00	77'	75
4:00	78'	75
5:00	78'	75
6:00	79'	74
7:00	79'	74
8:00	79'	74
9:00	80'	73
10:00	80'	73
11:00	80'	72
12:00	80'	72
1:00	81'	71
2:00	81'	71
3:00	81'	71
4:00	81'	71
5:00	81'	71
Recovery 6:00	81'	71
6:05	66'	—
6:10	55'	—
6:15	53'	—
6:20	50'	—
6:30	51	—

TEST PUMP HUALAPAI WILDLIFE MANAGEMENT WELL #1

Appendix B

Water Quality/Analysis Report

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGION
REGIONAL LABORATORY
*** REPORT OF WATER ANALYSIS ***

PART I — LAKE MOHAVE — ANALYSIS BY: DD,BH

LAB NO.	STATION CODE	SAMPLED BY	DATE SAMPLED	TIME SAMPLED	TEMP. C.	DATE RECEIVED	DATE ANALYZED	DESCRIPTION OF SAMPLING SITE AND RELATED INFORMAT
93-1268			6- 9-93			6-10-93	7-20-93	HUALAPI WELL TEST 1 OF 3 NUTRIENTS
93-1269			6- 9-93			6-10-93	7-20-93	HUALAPI WELL TEST 2 OF 3 NUTRIENTS
93-1270			6- 9-93			6-10-93	7-20-93	HUALAPI WELL TEST 3 OF 3 NUTRIENTS
93-1271			6- 9-93			6-10-93	7-20-93	HUALAPI WELL TEST 2 OF 6 MAJOR IONS
93-1272			6- 9-93			6-10-93	7-20-93	HUALAPI WELL TEST 4 OF 6 MAJOR IONS
93-1273			6- 9-93			6-10-93	7-20-93	HUALAPI WELL TEST 5 OF 6 MAJOR IONS

****

LAB NO.		EC (MICROMHOS)	TDS (MG/L) EVAP/SUM	% NA	CATIONS (ME/L)/(MG/L) NA	K	CA	MG	ANIONS (ME/L)/(MG/L) CO3	HCO3	CL	SO4	NO3 (ME/L)/(MG/L)	SIO2 (MG/L)
93-1268													.4	
													21.7	
93-1269													.4	
													25.4	
93-1270													.4	
													25.3	
93-1271	7.4	40[illegible]	237	9.5	.46	.02	3.80	.58	.00	3.60	.38	.41		
			237		10	0	76	7	0	219	13	19		
93-1272	7.5	[illegible]	247	9.6	.46	.03	3.75	.57	.00	3.50	.23	.40		
			227		10	1	75	6	0	213	8	19		
93-1273	7.6	413	258	10.3	.46	.03	3.40	.57	.00	3.57	.30	.38		
			224		10	1	68	6	0	217	10	18		

1 DATE [illegible]

UNITED STATES BUREAU OF RECLAMATION
LOWER COLORADO REGION
REGIONAL LABORATORY
*** REPORT OF WATER ANALYSIS ***

PART II — LAKE MOHAVE — ANALYSIS BY: DD,BH

LAB NO.	MINOR ELEMENTS (MG/L) B	F	NH4	PO4	TRACE ELEMENTS (UG/L, SIGMA) SE
93-1268			.2	.1	<2, .2
93-1269			.2	.0	<2, .2
93-1270			1.2	.0	<2, .2
93-1271					<2, .6
93-1272					<2, .3
93-1273					<2, 1.2

Appendix C

Arizona Historic Preservation Office Concurrence Letter

Mcphubis

UNITED STATES GOVERNMENT

memorandum

MAR 2 1 1995

DATE: Acting

REPLY TO ATTN OF: Phoenix Area Director
Environmental Quality Services

MAR TRUXTON CANON VALENTINE ARIZ.

SUBJECT: Determination for Purposes of Section 106 of the National Historic Preservation Act, Endangered Fish Rearing Facility

TO: Superintendent, Truxton Canon Agency
Attention: Environmental Coordinator

As the certifying authority at Supplement 2, 30 BIAM 1.5B(1), I have determined that the report Cultural Clearance for a Fish Rearing Facility at Frazier Well, AZ, Hualapai Ind. Res. (Hualapai Cultural Resource Program, February 1995) is accurate in its findings for purpose of compliance with the identification provisions of 36 CFR 800 and do herewith adopt its recommendations.

I find that the proposed undertaking contains no historic properties listed in or eligible for the National Register of Historic Places and invoke 36 CFR 800.4(d). For these purposes, approval may be granted for the proposed undertaking with the proviso that should cultural material be encountered in the course of construction, that work cease at that location and the Indian land owner and the Area Archeologist be notified immediately.

Barry W Welch

Appendix D

Threatened and Endangered Species Letters, From the U.S. and Fish and Wildlife Service

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ARIZONA ECOLOGICAL SERVICES STATE OFFICE
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

Telephone: (602) 640-2720 FAX: (602) 640-2730

March 10, 1995

In Reply Refer To:
AESO/SE
2-21-94-I-446

Ben H. Zimmerman
Hualapai Tribal Council
Hualapai National Resource Department
P.O. Box 300
Peach Springs, Arizona 86434

Dear Mr. Zimmerman:

The Fish and Wildlife Service (FWS) has reviewed the biological evaluation on the proposed endangered fish rearing facility at Frazier Wells on the Hualapai Indian Reservation in Coconino County, Arizona. The FWS agrees with the finding that the construction and operation of the proposed facility will not affect listed or proposed threatened or endangered species. Operation of the facility would contribute to recovery efforts for endangered Colorado River fishes.

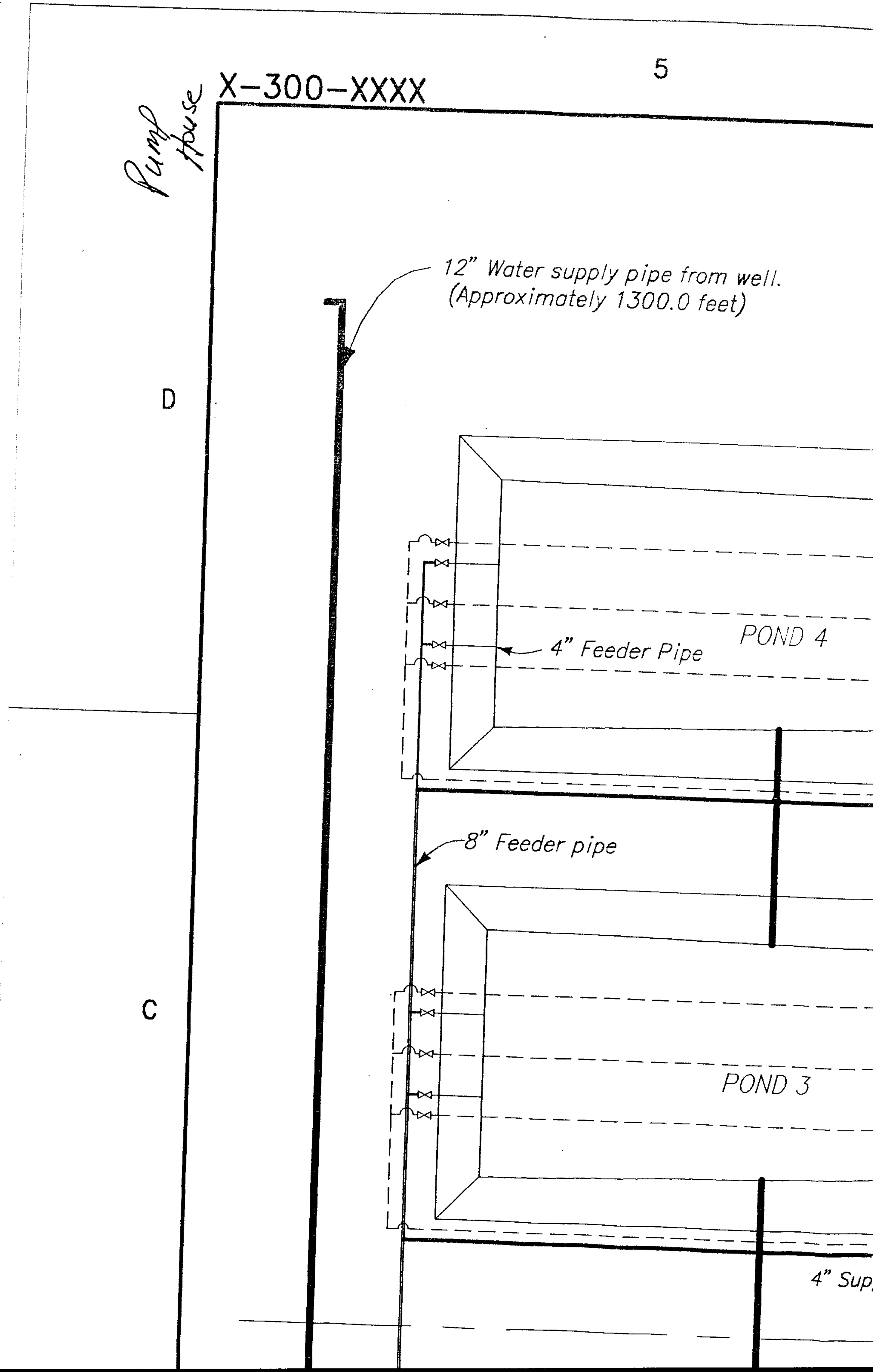
Thank you for your efforts to conserve listed species. If we may be of additional assistance, please contact Ted Cordery or Lesley Fitzpatrick.

Sincerely,

For Sam F. Spiller
State Supervisor

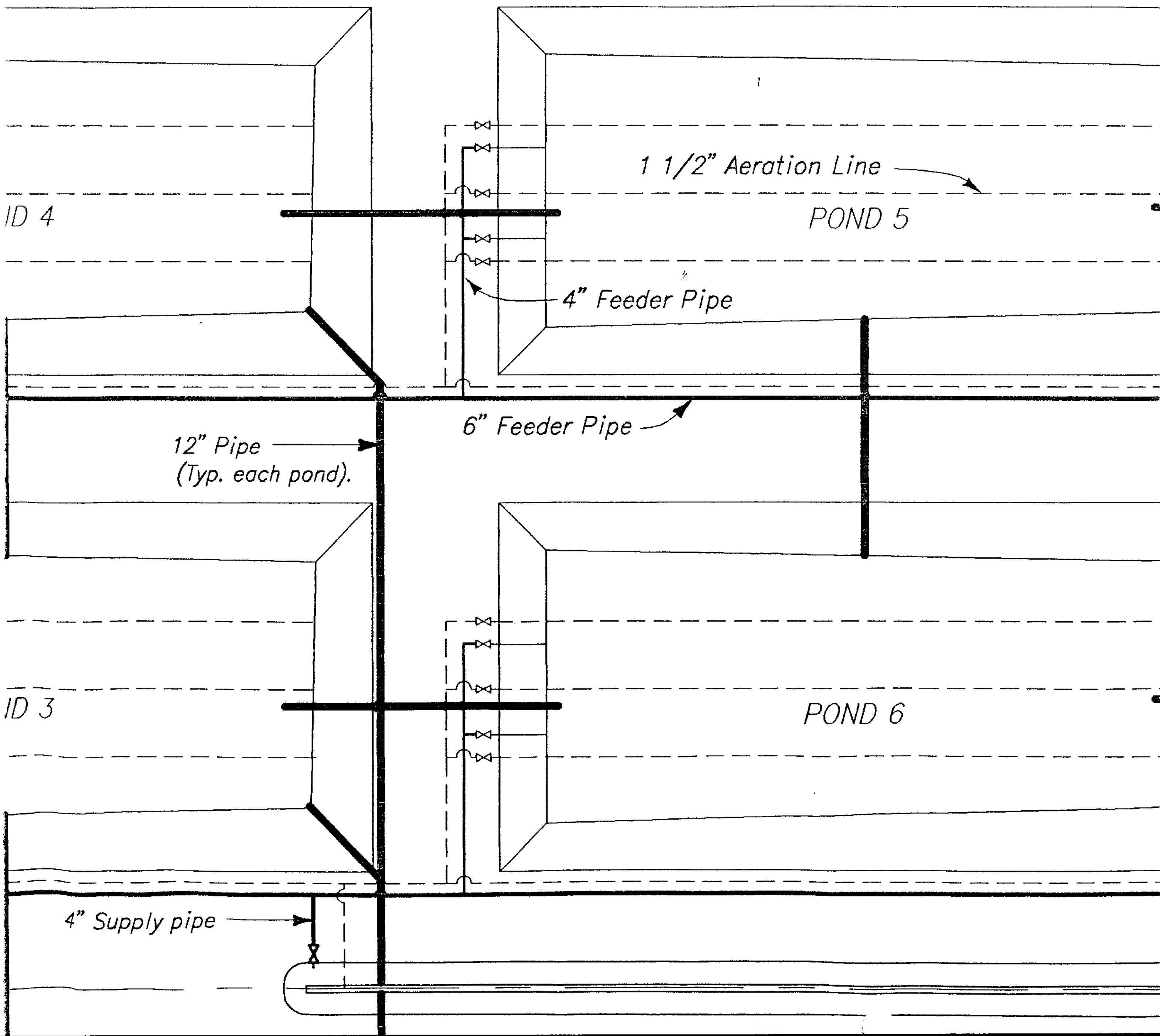
cc: Director, Arizona Game and Fish Department, Phoenix, Arizona
Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico (AES)
Project Coordinator, Parker Fisheries Research Office, Fish and Wildlife Service, Parker, Arizona
Project Leader, Pinetop Fisheries Assistance Office, Fish and Wildlife Service, Pinetop, Arizona

Appendix E
Facility and Drawing and Layout

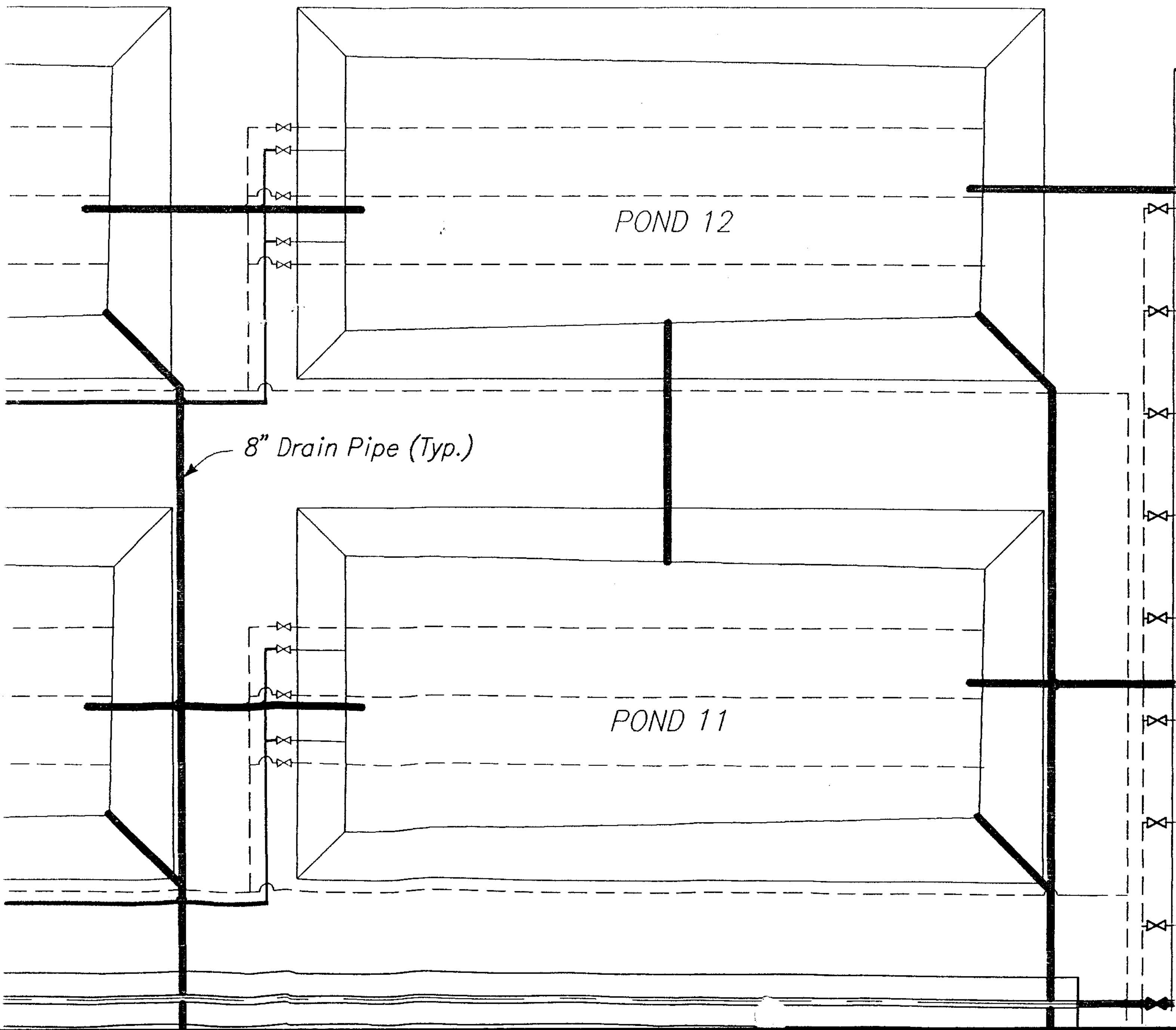

Pump House
X-300-XXXX
12" Water supply pipe from well.
(Approximately 1300.0 feet)
D
4" Feeder Pipe
POND 4
8" Feeder pipe
C
POND 3
4" Sup,

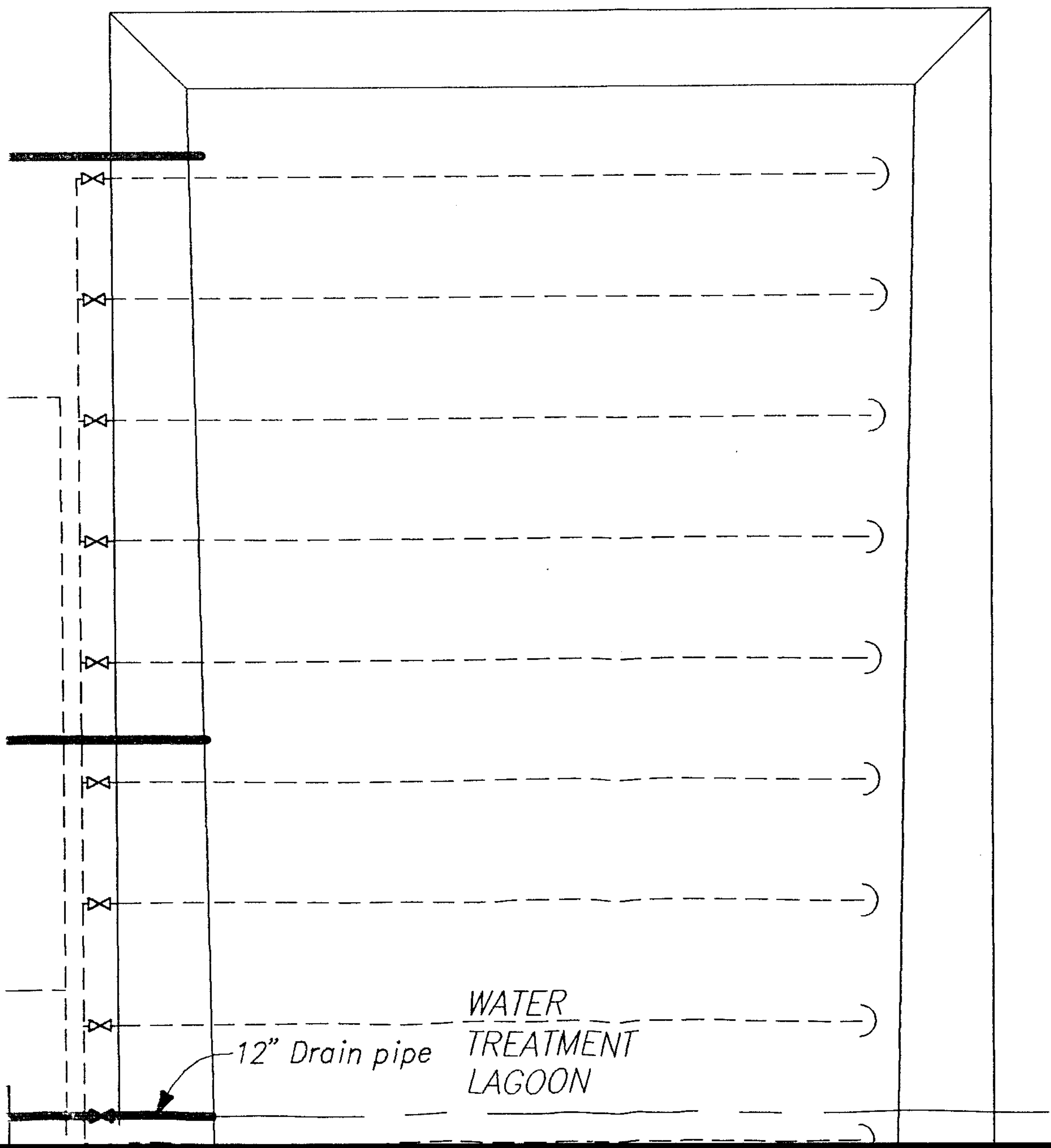
4

Fence

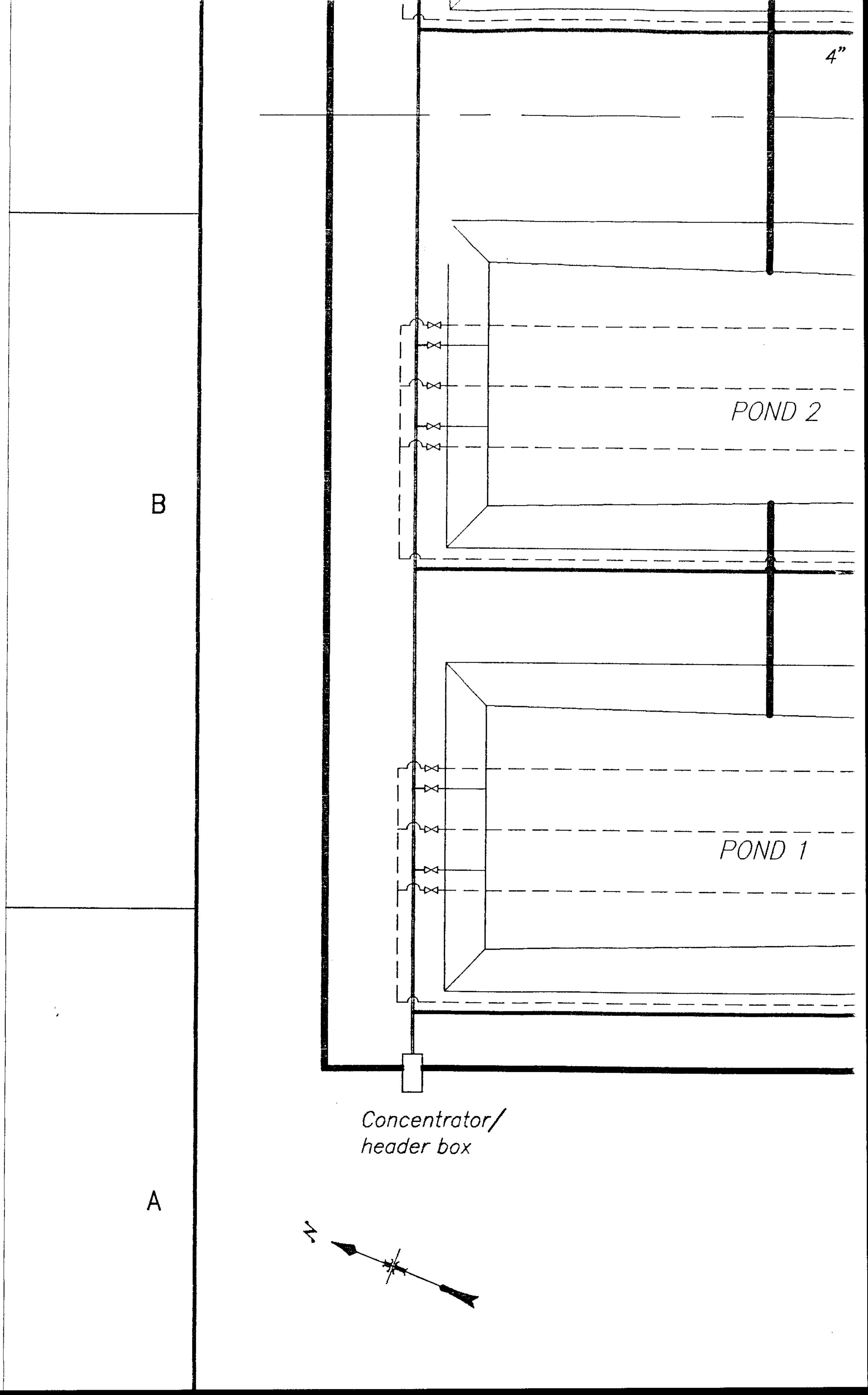

1 1/2" Aeration Line
ID 4
POND 5
4" Feeder Pipe
6" Feeder Pipe
12" Pipe
(Typ. each pond).
ID 3
POND 6
4" Supply pipe

3

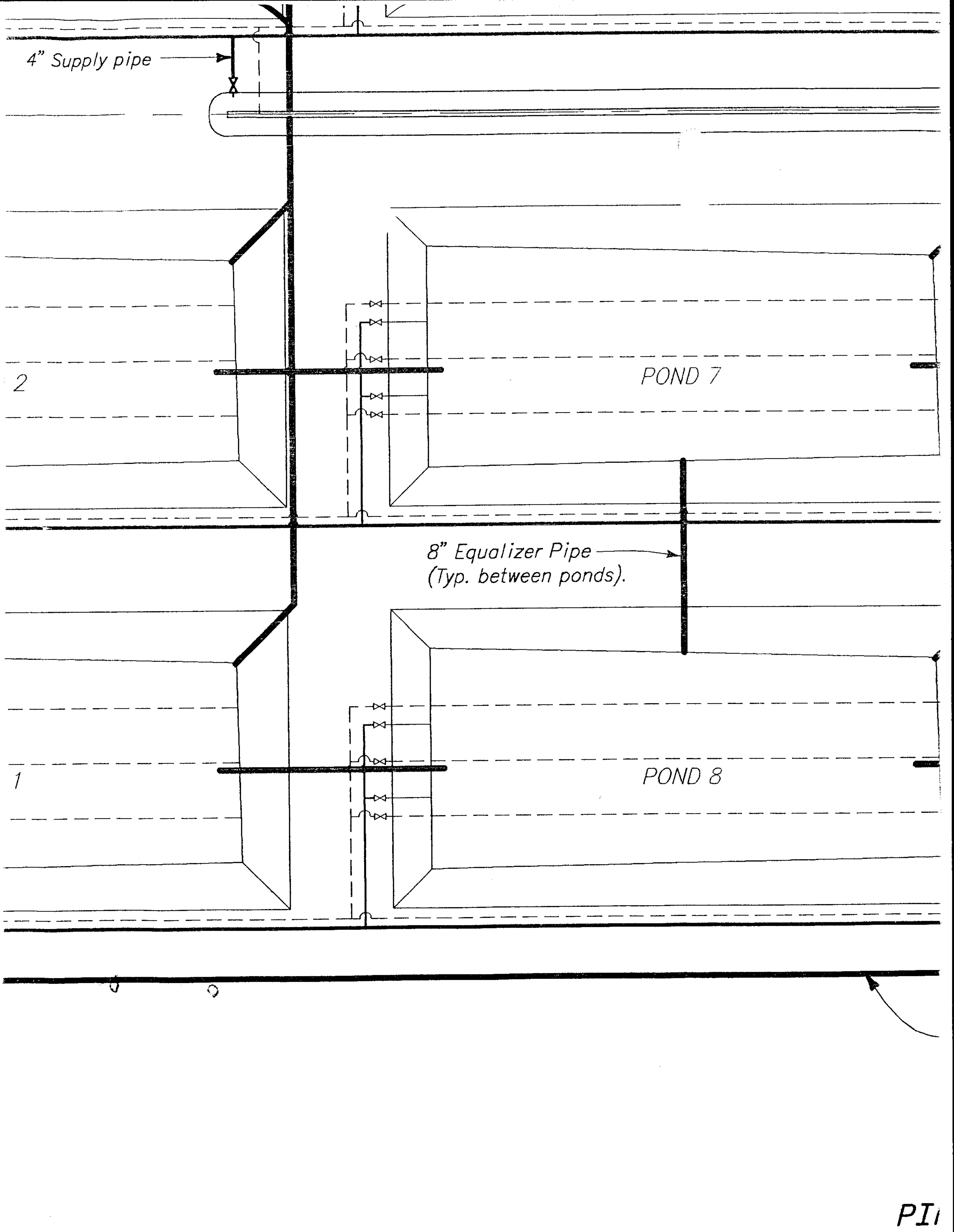




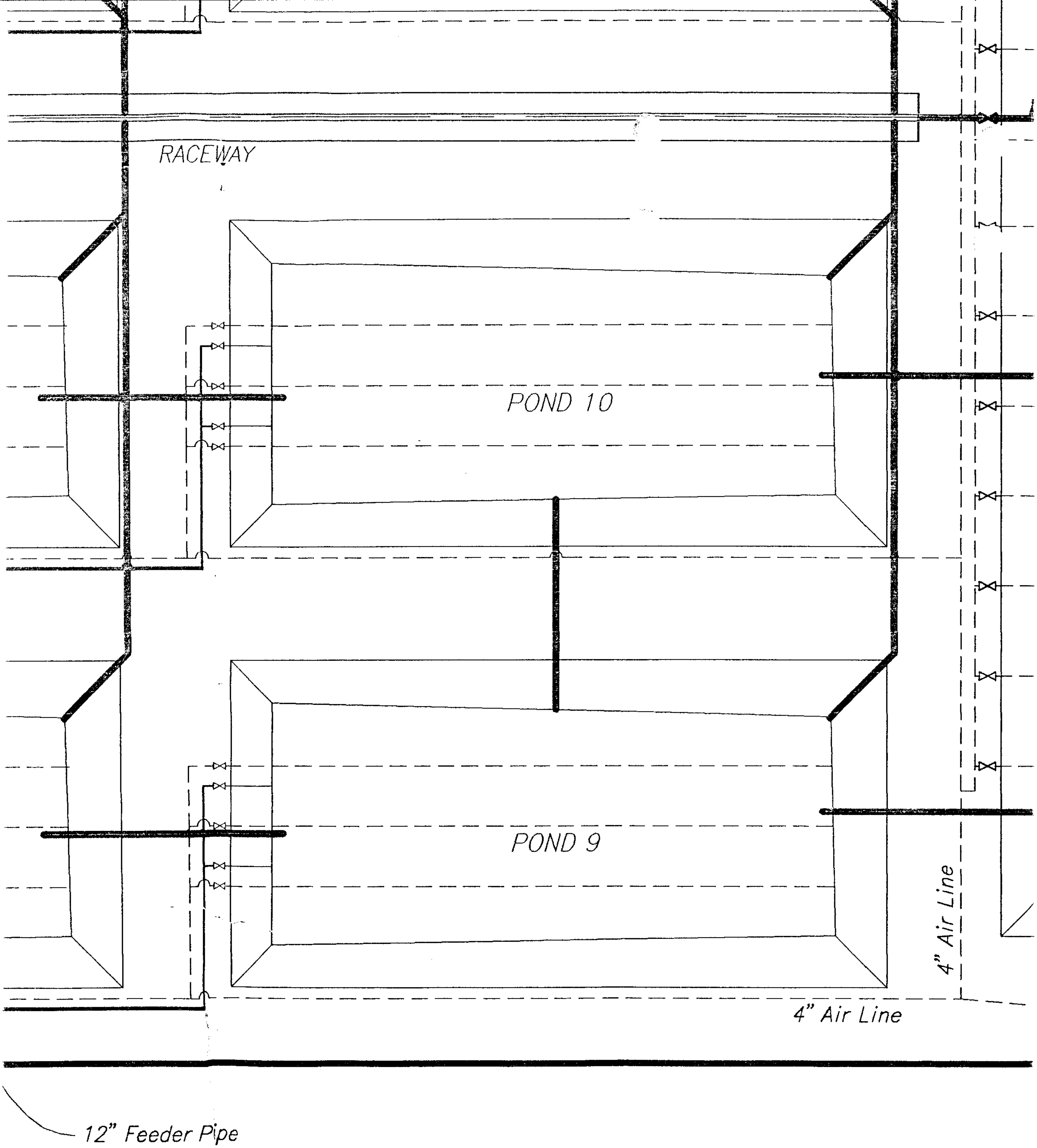
WATER TREATMENT LAGOON
12" Drain pipe



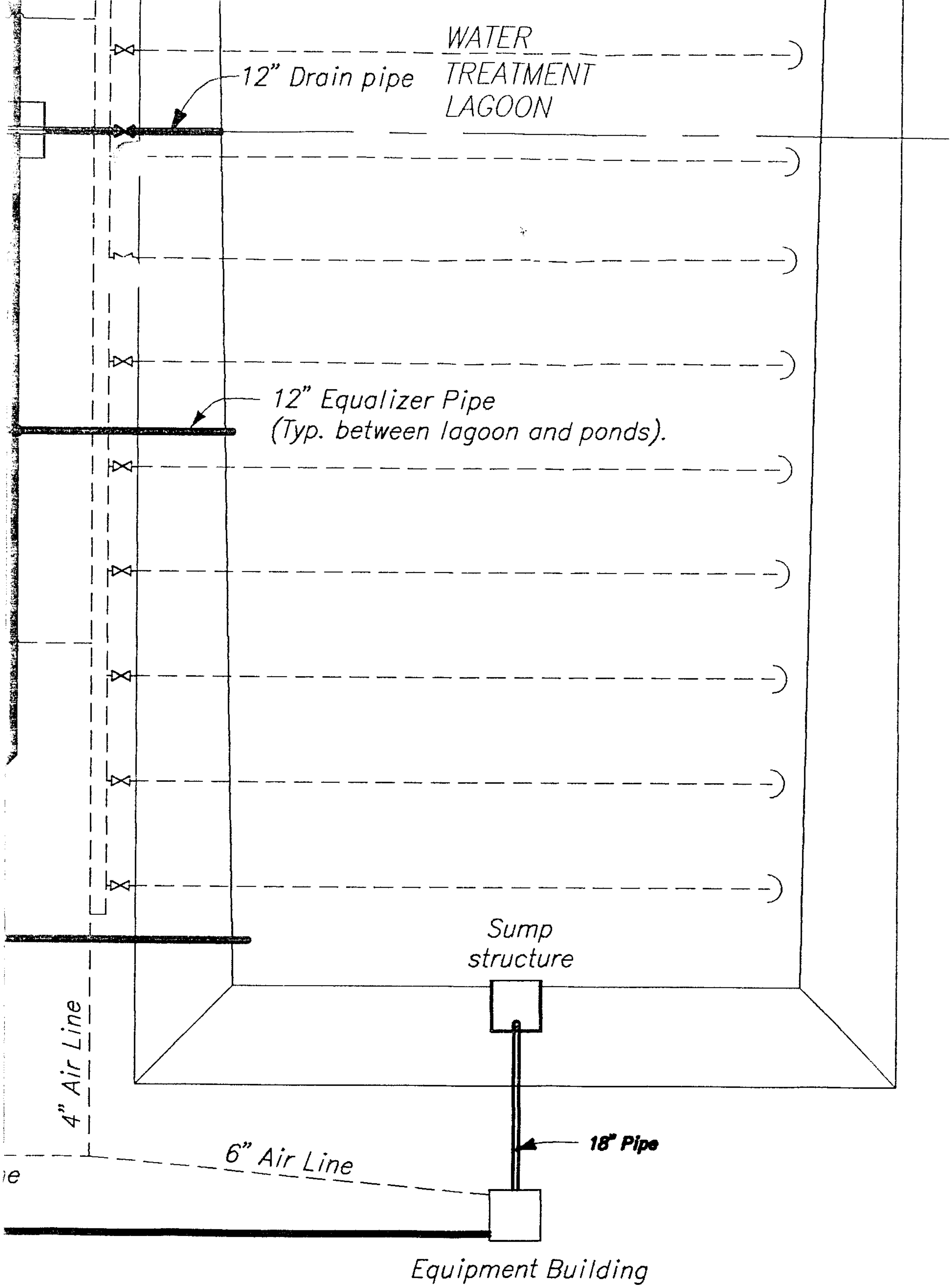
4"
POND 2
POND 1
Concentrator/
header box
N
B
A



4" Supply pipe
2
POND 7
8" Equalizer Pipe
(Typ. between ponds).
1
POND 8
PI



PIPE LAYOUT PLAN



DESIGNED Paul Sandov

DRAWN Allen L. Ayer

B

A

ALWAYS THINK **SAFETY**

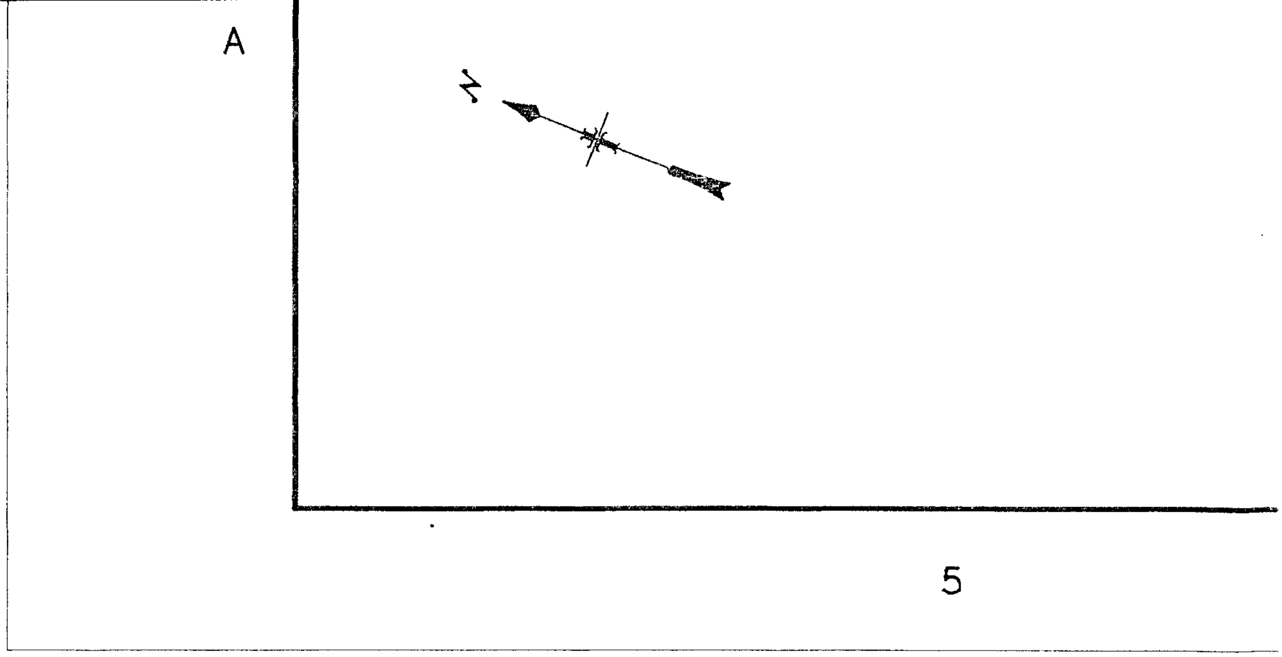
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
HUALAPAI INDIAN RESERVATION
PEACH SPRINGS , ARIZONA

REARING PONDS

FRAZIER'S WELL AREA

PIPE LAYOUT PLAN

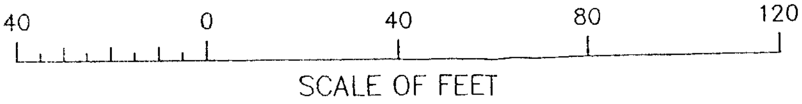
DESIGNED Paul Sandoval	TECH. APPROVAL
DRAWN Allen L. Ayers	SUBMITTED


A
5

40

	4

PIPE LAYOUT PLAN



3

BUREAU OF RECLAMATION
HUALAPAI INDIAN RESERVATION
PEACH SPRINGS , ARIZONA

REARING PONDS

FRAZIER'S WELL AREA

PIPE LAYOUT PLAN

DESIGNED Paul Sandoval	TECH. APPROVAL
DRAWN Allen L. Ayers	SUBMITTED
CHECKED	APPROVED REGIONAL ENGINEER

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD Rel. 12_c3	PS4.DWG	APRIL 19, 1996 09:30
BOULDER CITY, NEVADA	APRIL 30, 1996	X-300-XXXX

A